‘Fast’ solar wind emanates from coronal holes on the Sun and is observed at Earth with typical velocities of ~500-800 km s\(^{-1}\). In contrast, ‘slow’ solar wind originates from other regions on the solar disk and is typified by velocities of ~300-400 km s\(^{-1}\). Upon emission from the Sun, the fast wind catches up with upstream slow wind and a compressive region known as an interaction region (IR) is formed at the interface. The high speed solar wind stream (HSS) follows the IR. When such regions are formed due to fast wind from a recurring coronal hole with a ~27 day period, they are termed co-rotating interaction regions (CIRs). Such regions are detected at Earth most likely during the declining phase of the solar cycle when polar coronal holes extend towards the ecliptic plane. However there are also equatorial coronal holes and high speed wind around solar maximum. CIRs are detected by solar-wind monitors such as the WIND or ACE satellites, and may be recognised by typical features in plasma and magnetic field data such as:

a) an increase in solar wind speed from ‘slow’ to ‘fast’ for periods in excess of one day;

b) an east-west deflection in the solar wind velocity indicating the interaction between ‘slow’ and ‘fast’ solar wind;

c) local maxima in solar wind plasma density and interplanetary magnetic field (IMF) magnitude - signatures of the ‘pile-up’ of material at the leading edge of the fast wind.

Figure 1 shows signatures from a typical HSS and preceding CIR in solar wind data from the WIND satellite during February 1995, along with a selection of geophysical indices. An east/west deflection occurred around 9:00 UT on 10\(^{th}\) February. Prior to this time, the plasma velocity measured by WIND was ~ 350 km s\(^{-1}\) - characteristic of slow solar wind. Following this time, the solar wind velocity peaked at a value in excess of 600 km s\(^{-1}\), and remained elevated for at least five days. Strong Alfvénic fluctuations are a known characteristic of the IMF during high speed streams, and are evident throughout this period.

The “High Speed Solar Wind Streams and Geospace Interactions (HSS-GI) Workshop” was held from 2-7 September 2007 in Ambleside, UK, and hosted by the Department of Communication Systems at Lancaster University. 40 researchers from all areas of solar-terrestrial physics discussed the physical processes that occur during HSSs, how such events may differ from other transient phenomena such as interplanetary coronal mass ejections (ICMEs), and debated outstanding questions related to HSS interactions with geospace. Over the past few years the importance of HSSs for activity within the Earth’s magnetosphere has become increasingly accepted across the community. Although HSS events are not generally associated with large signatures in the Dst index (i.e. they do not produce a particularly strong ring current), they do produce storm-levels of other magnetospheric phenomena (enhanced convection, heating, precipitation, relativistic electron energisation etc.) which persist for an extended time-period (e.g. many days) in contrast to ICME events where more transient driving (e.g. one day) is the norm. As such, the energy input to the magnetosphere during HSSs is comparable or may exceed the energy input to the magnetosphere during ICMEs.
Although the importance of HSSs for magnetospheric activity is becoming increasingly acknowledged, much physics relating to the interaction between HSSs and geospace remains unresolved. During the meeting, participants agreed on a list of outstanding questions related to HSS/geospace coupling. These questions may be considered a ‘call to research’ for those active in solar-terrestrial studies.

1. What determines the coupling efficiency between the solar wind and magnetosphere during HSSs? How important are fluctuations in magnetic field ($B_s$) and solar wind velocity ($V_{sw}$)?

2. Which magnetospheric plasma waves are the most dominant for heating and losses of radiation belt electrons? What drives such waves?

3. What causes relativistic electron dropouts during storm main phases? How can we quantify the relative wave-particle loss rates?

4. How are Pc5 waves generated during HSSs? Which process dominates? Why are Pc5 waves so dominant in these events?

5. What in the solar wind drives high Dst? Why is the Dst signature low for HSSs?

6. What is the role of ring current composition during HSSs? What is the main ring current injection mechanism?

7. How do rapid solar EUV changes affect the ionosphere/plasmasphere during HSSs?

8. How important is particle energy deposition compared to EUV energy input during HSSs?

The workshop concluded with the agreement that HSSs and ICMEs are different, but equally important drivers of magnetospheric activity. Two events were selected for further co-ordinated studies by workshop participants and others (10-22 October 2003 and 10-16 November 2003). Those interested in participating in this study programme should contact one of us for further information. A follow-up workshop to digest results is planned for 2009.

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Figure 1: a) Typical signatures of a co-rotating interaction region (CIR) and subsequent high speed solar wind stream (HSS) observable in upstream solar wind data from the WIND satellite (GSE coordinates). Here, an east/west deflection in flow velocity occurred at ~9:00 UT on 10th February 1995. High speed solar wind persisted for at least five days following
this time and was accompanied by rapid Alfvénic fluctuations in the interplanetary magnetic field (IMF). b) Geomagnetic indices during February 1995. Although the Dst index, a proxy for ring current strength, changes little following the HSS arrival at the magnetopause, the Kp index, a proxy for the strength of convection, remains elevated for at least five days during the high speed stream (dark grey indicates Kp values in excess of 3. The Midnight Boundary Index indicates the edge of auroral precipitation in degrees. During much of the passage of the HSS the auroral precipitation is ~4° further equatorwards than its pre-event location.